COLUMN ASSEMBLY OF A VEHCILE HAVING A STEERING COLUMN TO BE LOCKED AND UNLOCKED

BACKGROUND OF THE INVENTION

1) Field of the Invention

[0001] The subject invention relates to a column assembly of a vehicle having a steering column to be releasably locked and unlocked.

2) Description of Related Art

[0002] Various assemblies are well-known for locking a steering column. One such assembly is a lock bolt that is spring-loaded into direct or indirect releasable engagement with the steering column. Such engagement can be achieved by removable insertion of the lock bolt into a groove, a notch, teeth, or an aperture in the steering column or in a gear, plate, or other element connected to the steering column. A mechanism is normally provided for retracting the lock bolt against the spring-loaded force to unlock the steering column for vehicle operation. As is well known to those skilled in the art, the mechanism can retract the lock bolt in response to user insertion and turning of a key or in response to one or more signals from a control system coupled to an actuator driving the mechanism.

[0003] One concern with such steering column locks is the ability of the lock to reliably lock the steering column and protect against the lock bolt engaging and locking the steering column during vehicle operation. For example, the lock bolt of a steering column lock should be able to properly extend and engage with the steering

column (or element connected thereto as described above) even when the steering column is being turned during non-operation. As another example, a familiar problem with many conventional steering column locks is the difficulty that a user experiences in turning the ignition key to unlock the column when a counteracting torque load is imparted to the column by back torque from the wheels. After the lock bolt has been inserted into the groove, notch, teeth, aperture and the like in its extended and locked position, the load from the front wheels can bind the lock bolt in this position and make it difficult to remove. Typically, the user must turn the steering wheel to release the force upon the lock bolt in order to turn the ignition key, retract the lock bolt, and thereby unlock the steering column.

[0004] In newer steering column locks that are not mechanically connected to an ignition lock cylinder for actuation, the lock bolt binding can be a significant problem. With the introduction in recent years of vehicle security systems in which a steering column lock is locked and unlocked by an electronic controller connected to one or more steering column lock actuators, there is little need to locate a vehicle's ignition control (e.g., switch, button, and the like) adjacent to the steering column lock. The ignition control can be directly or indirectly connected to the column lock by wiring alone, and therefore can be located almost anywhere in the vehicle. However, without the ability of a user to mechanically manipulate the lock bolt as in most older steering column lock designs described above, reliable lock bolt disengagement can be a significant problem, particularly when the lock bolt is subjected to binding forces.

[0005] One such way to overcome the load is by utilizing a more powerful lock bolt drive incorporating a larger motor. However, using the larger motor requires additional packaging space within the column assembly. Currently, the vehicle industry is striving to make the column assembly smaller and therefore, utilizing the larger motor is not desirable. Other methods of overcoming the load have incorporated additional mechanisms to push the lock bolt from the opposite side of the lock bolt drive. In this manner, the lock bolt drive is capable of overcoming a specific amount of force and the additional mechanism overcomes a specific amount of force such that when acting together, the lock bolt is moved to the unlocked position. However, adding additional mechanisms to overcome the load increases the packaging space required for the column assembly. Still other assemblies have attempted to use cams, pawls, and the like to reduce the load on the lock bolt. Others have attempted to design the lock bolt and the corresponding apertures in such a way that the load is minimized and overcome easier. In each of these assemblies, the load is not consistently and reliably released each time the column is locked and the assemblies do not assist in reducing the load. Further, when the column lock is not connected to the ignition control, these pawl, cams, and designs are less effective.

[0006] In sum, the assemblies of the prior art are characterized by one or more inadequacies. Therefore, it would be advantageous to provide a column assembly for a vehicle that reduces the load on the lock bolt consistently when the load is present to make unlocking of the steering column easier. Further, it would be advantageous to provide the assembly having fewer or smaller components, taking advantage of

components that are currently existing within the column assembly, thereby reducing the packaging of the column assembly.

BRIEF SUMMARY OF THE INVENTION

[0007] The subject invention provides a column assembly of a vehicle having a steering column to be releasably locked and unlocked. The assembly includes a steering column rotatable about a central axis and a lock bolt moveable from an unlocked position to a locked position to lock the steering column against rotation. When the lock bolt is in the locked position, a load is imparted to the lock bolt restricting movement of the lock bolt from the locked position to the unlocked position. A lock bolt drive is connected to the lock bolt for moving the lock bolt from the locked position to the unlocked position. However, in the locked position, the load prevents the lock bolt drive from being able to move the lock bolt from the locked position to the unlocked position. The assembly includes a release mechanism operative to reduce the load on the lock bolt sufficiently to enable the lock bolt drive to move the lock bolt from the locked position to the unlocked position.

[0008] The subject invention overcomes the inadequacies that characterize the related art assemblies. Specifically, the subject invention provides a column assembly that reduces the load on the lock bolt consistently, when the load is present, to make unlocking of the steering column easier. Further, the subject invention has smaller components and takes advantage of components that are currently existing within the column assembly, which further reduces the packaging of the column assembly.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0009] These and other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description and the accompanying drawings wherein:

[0010] Figure 1 is a perspective view of a vehicle having a column assembly according to the subject invention;

[0011] Figure 2 is a cross-sectional side view of the column assembly having a lock bolt and a lock bolt drive housed together with a release mechanism to reduce packaging of the column assembly;

[0012] Figure 3 is a environmental side view of the column lock assembly having the lock bolt and the lock bolt drive housed separately from the release mechanism;

[0013] Figure 4A is an exploded perspective view of the lock bolt and the lock bolt drive of the subject invention; and

[0014] Figure 4B is an assembled perspective view of the lock bolt and the lock bolt drive of the subject invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] A column assembly for releasably locking and unlocking a steering column **12** of a vehicle **14** is shown generally at **10** in Figure 1. The column assembly **10** is typically formed as part of a steering system of the vehicle **14**. The steering system includes a steering column **12** rotatable about a central axis **13** for imparting a direction to the vehicle **14**. A steering wheel **15** is mounted at one end of the steering

column **12** and the other end of the steering column **12** engages a drive axle **16**. The steering system may be any one of an electric power, a hydraulic, or a pneumatic steering system. As is becoming common within the vehicle industry, many steering systems are employing steer-by-wire systems. Most of the steer-by-wire systems include a steering assist mechanism for providing feedback to a driver while steering the vehicle **14**. The vehicle industry is also attempting to reduce the packaging and the size of the column assembly **10**, while also making the vehicle **14** more secure against theft. Therefore, it is advantageous to utilize existing components within the column assembly **10**, such as the steering assist mechanism to minimize the size of the column assembly **10**.

[0016] When the vehicle **14** is not being operated, one method for preventing theft of the vehicle **14** is to lock the steering column **12**. Once locked, the column assembly **10** will be unlocked when the vehicle **14** is properly started with a key or similar device or upon receiving a signal. In order to lock the column assembly **10**, a lock bolt **18** is moveable from an unlocked position to a locked. When in the locked position, the steering column **12** is prevented from rotating which imparts a load onto the lock bolt **18**. The load is typically imparted from the front wheels **19** of the vehicle **14** as understood by those skilled in the art. The load is preferably a side load restricting movement of the lock bolt **18** from the locked position to the unlocked position. By side load, it is to be appreciated that since the steering column **12** wants to rotate about the central axis **13**, the side load is acting against the side of the lock

bolt **18**. It is to be appreciated that those skilled in the art will recognize that other forces may be present to restrict movement of the lock bolt **18** other than as described.

[0017] In order to move the lock bolt **18** from the locked position to the unlocked position, a lock bolt drive **20** is connected to the lock bolt **18**. However, the load acting on the lock bolt **18** prevents the lock bolt drive **20** from being able to move the lock bolt **18** from the locked position to the unlocked position. It is to be appreciated that the lock bolt drive **20** may be any type of drive, but is preferably an electric motor.

[0018] The assembly **10** includes a release mechanism **22** operative to reduce the load on the lock bolt **18**. The release mechanism **22** reduces the load sufficiently to enable the lock bolt drive **20** to move the lock bolt **18** from the locked position to the unlocked position. For example, if the load acting on the lock bolt **18** is 80 Newton meters (N-m), and the lock bolt drive **20** is only able to overcome 50 N-m, then the release mechanism **22** must reduce the load by 30 N-m. One way to reduce the load is to have a release drive **24** engaging one of the steering column **12** and the lock bolt drive **20** to rotate either one of the steering column **12** and the lock bolt drive **20** circumferentially to release the load. Preferably, the release drive **24** engages the steering column **12** either directly or indirectly. Since the load is being imparted due to rotation of the steering column **12** being prevented, if the steering column **12** is rotated against the load, then the load will be reduced and will enable the lock bolt drive **20** to remove the lock bolt **18**.

[0019] Preferably, the release drive **24** is coupled to the particular steering system of the vehicle **14** and utilizes components currently existing in the column assembly **10**. This allows for a more compact design of the column assembly **10** since no additional components are being added. Further, since the release drive **24** is reducing the load on the lock bolt **18**, the lock bolt drive **20** is able to be smaller and more compact, which further minimizes the size of the column assembly **10**. The release drive **24** may be an electric motor used as the steering assist mechanism in the electric power steering system, a hydraulic motor used in the hydraulic steering systems, or a pneumatic motor used in the pneumatic steering system. It is to be understood that any one of the motors may be replaced with an equivalent device separate from the steering system, while still reducing the load on the steering column **12** sufficiently to enable removal of the lock bolt **18**.

[0020] Referring to Figures 4A and 4B, the lock bolt **18** and the lock bolt drive **20** are shown in an exploded view and in an assembled view, respectively. The lock bolt drive **20** includes a housing **26** having a front cover **28** and a rear cover **30** such that the lock bolt **18** extends from the front cover **28**. Housed within the housing **26** is a worm **32** and a worm gear **34** disposed between the motor and the lock bolt **18** for moving the lock bolt **18** from the locked to the unlocked position. The lock bolt drive **20** is also housed within the housing **26** and is preferably an electric motor, and more preferably a 5-ounce inch motor. The electric motor is turned on and off by a switch **36** which is connected to a power source **(not shown)**. The power source preferably powers both the lock bolt drive **20** and the release mechanism **22**, however, it is to be

appreciated that each may have it's own power source. Most preferably, the power source is the battery used by the remainder of the vehicle **14** systems. The lock bolt drive **20** also includes a spring **38** biasing the lock bolt **18** outwardly from the front cover **28** and a carrier **40** for carrying the lock bolt **18** along the worm gear **34** and for transmitting movement between the locked and unlocked positions. Various bearings **42** also support the worm gear **34** to provide movement of the lock bolt **18** and an up-stop **44** prevents the lock bolt **18** from being moved to far. A switch actuator **37** is supported by the carrier **40** for actuating the switch **36**.

[0021] Referring to Figure 2, the column assembly **10** may also include a sensor **46** in communication with the lock bolt drive **20** and the release mechanism **22** for sensing the load on the lock bolt **18**. The sensor **46** is able to detect a direction of the load, such as clockwise or counterclockwise about the central axis **13**, on the lock bolt **18**. Preferably, the sensor **46** is positioned adjacent the steering column **12** to sense the load, however, it may be positioned elsewhere so long as it is capable of sensing the load. Upon detection of the load, the sensor **46** transmits a signal to a processor **48**. The processor **48** is in communication with the sensor **46**, the lock bolt drive **20**, and the release mechanism **22** and coordinates operation of the lock bolt drive **20** and the release mechanism **22** to release the load. The processor **48** is preferably included with the vehicle's **14** electronics that are used to run the remainder of the vehicle's **14** systems as is known to those skilled in the art. If the sensor **46** detects a clockwise load on the lock bolt **18**, then the processor **48** directs the release mechanism **22** to rotate in a counterclockwise direction to reduce the load and vice versa for the

counterclockwise load. If the sensor **46** is not utilized, then the release mechanism **22** may rotate the steering column **12** in both the clockwise and counterclockwise direction until the load is reduced to allow removal of the lock bolt **18**. Other loads may be present other than the clockwise and counterclockwise loads depending upon the specific configuration of the lock bolt **18**, the lock bolt drive **20**, and the release mechanism **22**, so long as the loads prevent the lock bolt **18** from being moved to the unlocked position.

[0022] In one embodiment, shown in Figures 1 and 2, the release mechanism **22** further includes a worm **50** disposed between the release drive **24** and the steering column **12** for rotating the steering column **12** circumferentially. The worm **50** extends from the release drive **24** and engages a worm gear **52** disposed between the worm **50** and the steering column **12**. The worm gear **52** defines a plurality of holes **54** spaced circumferentially about the worm gear **52** for receiving the lock bolt **18** in the locked position. Preferably, the housing **26** of the lock bolt drive **20** is housed within the column assembly **10** along with the release mechanism **22** such that packaging space and size of the column assembly **10** is reduced within the vehicle **14**.

[0023] In another embodiment shown in Figure 3, the steering column **12** defines a plurality of apertures **56** for receiving the lock bolt **18**. In other words, the lock bolt **18** directly engages the steering column **12** to prevent rotation. The plurality of apertures **56** are spaced circumferentially about the steering column **12** to allow the lock bolt **18** to be adjacent the next nearest aperture **56** when moved into the locking position. In this embodiment, the release mechanism **22** is similar to that shown in

Figure 2, except that the lock bolt **18** does not engage the release mechanism **22**, since it is engaging the steering column **12**.

[0024] In operation, when the vehicle **14** is stopped and turned off, the lock bolt drive **20** moves the lock bolt **18** to the locked position. If the lock bolt **18** does not align with one of the holes **54** or apertures **56**, the lock bolt **18** is forced into the housing **26** against the force of the spring **38**. When the steering column **12** is rotated, such as by the driver turning the steering wheel **15**, the lock bolt **18** is biased outwardly from the housing **26** and through the hole **54** or aperture **56**. Once the lock bolt **18** engages the hole **54** or aperture **56**, the steering column **12** may still want to be rotated about the central axis **13**, by either a force of the wheels **19** of the vehicle **14** in contact with the ground or by the driver. This attempted rotation causes the load to be present on the lock bolt **18**. The load is sufficient enough to prevent the lock bolt drive **20** from being able to move the lock bolt **18** to the unlocked position.

[0025] When the vehicle **14** is to be operated again, the steering column **12** must be unlocked. In order to unlock the steering column **12**, the load on the lock bolt **18** must be reduced sufficiently to allow the lock bolt drive **20** to move the lock bolt **18**. It is preferred that the moving of the lock bolt **18** and the reducing of the load happens simultaneously to provide most efficient operation of the vehicle **14**. However, it is to be appreciated that a delay may be present between the reducing of the load and the moving of the lock bolt **18**. In order to reduce the load, the column assembly **10** senses the load and rotates one of the steering column **12**, the lock bolt **18**, and the lock bolt drive **20** circumferentially about the central axis **13**. Once the load is

sufficiently reduced, the lock bolt **18** is moved to the unlocked position and the steering column **12** is unlocked. In the most preferred embodiment, the steering column **12** is rotated circumferentially to reduce the load. Further, if the sensor **46** is not used, then the steering column **12** may be rotated both clockwise and counterclockwise until the load is overcome and the lock bolt **18** is moved to the unlocked position.

[0026] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. The invention may be practiced otherwise than as specifically described within the scope of the appended claims.